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Organisation Readiness Factors Towards IPv6 Migration: Expert Review

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Abstract

Background: Internet Protocol (IP) is one of the Internet's addressing protocols that allow devices to link to each other. At present, the existing IPv4 protocol gradually been migrated to the new the protocol which is IPv6 to afford a larger address scale and to facilitate various improvements of the protocol. However, the organisation's readiness has been identified as one of reason lead the migration to be slower than it should. In our previous study, content analysis helps us to identify the component that may influence the readiness via several articles and journals. Thus, the factors can be categorized into two categories which are physical factors; IPv6 deployment (planning), equipment and cost, while human factors involve of knowledge, training and motivation. Therefore, by conducting on structured interview from several IT experts and practitioners, our aim is provide better understanding on the identified factors by analysing their experiences and view. Results upon data collected show that they agreed with the factors that have previously been identified from literature. Finally, the factors can be used to develop a Organisation Readiness Model for assessing the organisation's readiness towards IPv6 migration process.

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Keywords: organisation, readiness, migration

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1. Introduction

Internet Protocol (IP) is a communications protocol that allows packets to be delivered in the network using the Internet Protocol suite. Every device connected to the internet needs a unique IP address and the number of the addresses is structured by the standard named Internet Protocol (IP). At present, Internet Protocol version 4 (IPv4) is applied and allocated space for 4.3 billion addresses. Though, with the increase of Internet users and Internet-enabled devices, the number is nearly been met (Kaur & Tan, 2013). In order to counter the limitations of IPv4, IPv6 was introduced to support a high number of IP address. However, IPv4 is expected to remain in use until the IPv6 protocol has been fully utilized because many companies still are not ready to move on (Bosire, 2013) despite the urgent need to migrate to IPv6. In addition, failed to make the transition or at least does not have plans to make in the near future could lead to disaster for the internet user (Shomoro, 2014). This issue leads to the slow progress of IPv6 development (Henten & Tadayoni, 2013).

The implementation of IPv6 will bring great changes to the Internet as it adapts to cope with the introduction of the new protocol. Yet, migrating from IPv4 to IPv6 in a sudden is impossible because of the large size of Internet and the huge number of IPv4 users. Therefore, in the context of migration from IPv4 to IPv6, the process will be a lengthy period as the two protocols will co-exist at certain years (Mackay & Edwards, 2003) since Internet users cannot tolerate with any down-time for the IP protocol replacement. If the organisation is completely terminate support for IPv4 in their networks, all IPv4 application such as websites, and services can no longer be functional. Therefore, by continuing to support IPv4, and at the same time, gradually increase the application for IPv6, the cost can be minimized than upgrading and testing all applications at once (Weng, 2012).

Technology adoption has been widely studied in the literature using various models of migration. However, there are several factors that are important have not covered yet (Das, Drogon, Jukan, & Hoffmann, 2014) especially in the context of organisation readiness. Generally, migration process involves not only technical issues, but it involves many aspects such as organisation preparation, vendor support and ISP readiness to make the adoption of the new protocol success. Yet, many studies have been made only concerning on the technical aspect, especially the potential of the new protocols and the weaknesses of the existing Internet protocols whereas such a critical issues, mainly on the organization's IP migration process (decision making process) has been taken for granted (Shomoro, 2014). Additionally, there are only a few non-technical research carried out for this (Kaur & Tan, 2013). In reality, research on IP migration process will help organizstions to decide whether they will migrate or not to IPv6 with less pressure.

The objective of this on-going research is to provide a better understanding about the factors of the organisation readiness for IPv6 migration to assist the process of preparation towards IPv6 adoption from an IT expert and practitioner perspective by considering their experience. The specific objective is to develop Organisation Readiness Model for assessing the organisation's readiness towards IPv6 migration process. To achieve this, several factors were identified from previous study which can influence the above matter. By referring to the factors, structured interview has been carried out to confirm that the factors can be used to develop the readiness model for IPv6 migration.

2. Literature Review

2.1 IPv6 Migration

In the technology world, migration is a one-way trip that can be referred as a variety of changes on hardware, software, and/or storage, where one or more people adapt to that new situation. It is generally embark on, only after careful study and research in an organisation. However, in the context of IPv6 adoption, most of the organisation feel pressured to face the transition from Internet Protocol version 4 (IPv4) to IPv6, when they still need to support both network topologies. This is because, most network providers realise that the migration is a very complex process and requires a lot of preparation and resources in terms of manpower, time and money (Suresh V. Limkar, Jha, Patil, & Maroti Kalbande, 2010). Hence it is important to emphasise that the success of migration will depend

on the availability of the infrastructure adapted to the new technology. In addition, with the daily operations of the business using the internet, this process cannot be done in a short time since it might affect the organisation's operation.

Migration to IPv6 is an essential in the long term as Internet has a large scale network that will have more users and its ability to be scaled before IPv4 is unseen. In addition, IPv6 is not just about IP address space, there are several other advantages that are classified as cost savings for network (Che & Lewis, 2010) because the capability of IPv6 with built-in auto-configuration mechanisms which will permit clients to communicate with one another without any human involvement. Indirectly, this will not only save the network administrator time, but also the cost as less hardware is needed to manage the network.

Though, most organisations will not be able to just flip a switch to make all their applications and equipment's are IPv6 ready as the current operations are run in the IPv4 environment. They must be able to manage applications and network infrastructure, design the network architecture and security systems that at the same time support both IPv4 and IPv6 to ensure a successful transition to IPv6. In addition, application services such as network firewalls, user access management tools, application delivery tools, must be featured into any IPv6 migration plan (Kumar, 2014). Therefore, to properly handle the burden of IPv6 transition, organisations need an appropriate migration plan as a tool to help provide smooth transition between the two standards. Several factors influencing the migration need to be identified so that they know the critical factors which need to be highlighted in preparation towards the migration.

2.2 Organisation's Readiness towards IPv6 Migration

As the migration to IPv6 is a must action that needs to be implemented sooner, the organisation has to be accepted and coped aggressively within a specified time frame. Yet, very little preparations have been made within the organisation (Suresh V. Limkar et al., 2010). In addition, organisations that remain to depend on the IPv4, with no plans for applying IPv6 in the future, may face difficulties to their business; especially cost and limited website functionality. Dell (2012) discovered in his study that very few organisations have made planning for IPv6 deployment, as they do not see any necessity towards the new protocol. This indicates that they are not ready towards the process of this migration.

There are several definitions related to the readiness are presented from the previous literature. Oxford Dictionary defined the readiness as the state of being totally equipped for something or preparedness of doing something. In the context of technology, readiness defined as the capability of a country to participate in the digital economy era (Budhiraja & Sachdeva, 2002) while, Dada (2006) defined readiness as the measurement of degree to which a nation, society or economy is willing or ready to obtain the benefits arising from the information and communication technology (ICT). On the other hand, organisation readiness described as the ability of the organisation to adapt to the changing environment and incorporate with the new technology (Lehman, Greener, & Simpson, 2002). This is closely related to the behavior of members of the organisation, either willing to accept the changes or not as concluded by Armenakis, Achilles, Stanley, & Kevin (2009), stated that readiness is the cognitive precursor to the behavior, whether opposition to or support for a change. It is described as a member's belief, attitudes and intentions regarding the extent to which the changes required and the ability of the organisation to succeed making the changes.

In the case of IPv6, Nguyen Phu Minh Nguyen et al. (2012) determine that readiness is form of preparation of personnel, systems, or organisations to meet the new situation and perform any activities based on what have been gathered towards the IPv6 migration. It was based on the completeness of planning, personnel training, and supplies for support services. Besides, readiness intended as how they should get ready for the migration as well as fully implementation of IPv6 (Dell, 2012). In this situation, the organisation must be prepared for the adoption of IPv6 into the network when the need comes (Nguyen Phu Minh Nguyen et al., 2012). Therefore, readiness can be conclude as the state of preparedness and capability (Aziz & Salleh, 2011) of the group to run IPv6 migration through personnel support, environment and infrastructure. Thereby, several studies have been discussed on the importance of the organisation readiness towards IPv6 migration; (Gold, 2011)) point out that, any

institution that is plan to migrate to IPv6 must measure their readiness as a first step in the planning process, since if they are not ready for IPv6, it can contribute a key difficulties in the ICT industry (Dell, 2012).

In our prior work, we have identified the factor that may influence the organisational readiness to migrate to IPv6 based on the document review analysis. As a result, the factors can be classified into two categories which are physical factors; IPv6 deployment (planning), equipment and cost, while human factors involve of knowledge, training and motivation. Thus, the contribution of this paper is to gather the information and view from several practitioners and IT experts on the factors that may influence the readiness in the organisation. Thus, the findings from the expert view will be compared with the factors that have previously been identified from literature.

3. Methodology

3.1. Research Goal

The aim of this study is to explore the factors that influence the readiness of an organisation towards IPv6 migration from the perspective of IT experts and practitioners. The opinion and experience thus can provide better understanding to assist the process of preparation towards IPv6 adoption by considering their experience. In order to achieve this objective, a qualitative research method, which is empirical data collection, was performed.

3.2. Sample and Data Collection

For the empirical study, data was collected through interviews. The study was conducted to five IT experts and practitioners who are listed as a stakeholder in the Malaysia IPv6 Roadmap document. The respondents are from bank, vendor, Internet Service Provider (ISP), educator (senior lecturer in computer networking field) and Malaysian Communications and Multimedia Commission (MCMC). Those respondents are directly involved in the field of computer networks and well experienced in their respective fields. They have been selected as their knowledge and perceptions about the technology to be adopted, can be used to make decisions for adopting new technologies (Rogers & Everett, 1983). The factors that are identified previously from the literature then been analysis by comparing with the perspective and opinion by the experts.

3.3. Analyses and Results

The interview data was analyzed using open coding technique that requires us to make reading and re-reading the interview transcripts to identify label and distinguish the important characteristics. Then, we combine those features with strong commonalities into a single theme which are factors that influence the organization readiness towards IPv6 migration. In this study, those factors have been identified from prior study. The six themes are IPv6 deployment (planning), equipment and cost representing the physical factors, while human factors involve of knowledge, training and motivation. Table 1 shows the six themes and the question while Table 2 shows the study finding associated with those factor.

Table 1 : Factors and Question

Factors	Question
Deployment (planning)	Does the organisation need to start/doing any effort to show that they are aware of this migration process?
Equipment	How about the equipment in the organisation? Which equipment need to be replaced or upgraded?
Cost	Will this migration involve with big amount of cost? (what will effect more when we talk about the cost?)
Knowledge	How about the knowledge should be given to the staff in the organisation?
Training	What type/form of training needed by the organisations to train their technical/IT person who will be involved in this migration process
Motivation	What motivation that drives an organisation to migrate from current protocol to IPv6 protocol

Table 2: Study finding

Theme	Respondent 1 (MCMC)	Respondent 2 (ISP)	Respondent 3 (vendor)	Respondent 4 (educator)	Respondent 5 (bank)
Deployment (planning)	Participant mentioned that the organisation should start to plan to migrate to IPv6 and should also consider the implication if not adopting IPv6	Participant believes that few organisations already started to explore the IPv6 since it has been in the roadmap blueprint. However, she suggested that trial is required before they can plan the migration	Participant emphasised that organisation need to have proper master plan on how to migrate. Besides that, he think that awareness is also important to promote the IPv6 within the organisation	Participant believes that the direction and instruction form government are needed for any organisation to migrate. However, she also agree that a proper milestone needs to be known as an effort towards IPv6 migration planning	Participant agreed that organisation have to prepare proper plan especially on cost, complexity of infrastructure and legacy system issue because the transition will involve major deployment cost. However, she mentioned that some organisation will do the changes depend on the direction from government, but still they need to analyse the return of investment.
Equipment	Participant believed that the replacement and upgrading the equipment is depend on the assessment by the organisation	Participant stated that most of transmission and IP transport has dual IP protocol capabilities where it can support IPv4 and IPv6 function concurrently. However, she believe that not all network element supported IPv6 and some software upgrade is required to make it ready	Participant confirmed that all equipment must support including the end user devices such as mobile phone	Participant suggested that organisation need to check the existing equipment whether they are compatible with IPv6 or not, to estimate on the cost of replacing with IPV6 compatible equipment	She claimed that all devices need to be replaced or upgraded include networking and end user devices

Theme	Respondent 1 (MCMC)	Respondent 2 (ISP)	Respondent 3 (vendor)	Respondent 4 (educator)	Respondent 5 (bank)
Cost	Participant believed that the cost of	Participant think that costing wise is	Participant accepted that the	Participant presumed that if the	Participant expected that the organisation should

	equipment and its configuration can be minimized by implementing proper assessment at the early stage of deployment. Other than that, the organisations also need to urge the ISPs not to raise the cost should they request for IPv6 enable connectivity.	depend on the scope of network upgrading. However, she claimed that the cost is actually some investment for the company	cost will depend on the organisation current network equipment and end user equipment	organisation can survive with the current IPV4 without having to spend a lot of money, she think that IPv4 will still be relevant for the next few years. Therefore, the cost for upgrading the equipment may not be necessary at the moment	provide the cost for training, infrastructure and consultation cost
Knowledge	Participant listed the knowledge that should be provided to the technical staff which are : Configuring IPv6 addressing, Enable IPv6 routing and Configuring IPv6 on the security appliance	Participant mentioned that all staff should be have knowledge on IPv6 overview and basic knowledge on IPv6	Participant emphasised on the awareness of IPv6 to normal user	Participant believed that most of the users have no knowledge about current IPV4 because they are the end user and it is not crucial for them to know, as well as the implementation. However, for IT and networking staff, they need to know at least basic knowledge about this new protocol	Participant emphasised on basic knowledge and technical skill on hardware configuration as well as troubleshoot issue
Training	Participant listed the type of training should be provided for technical staff which are : IPv6 Certification Training and IPv6 Consultative Program	Participant believed that IPv6 courses such as IPv6 configuration, advanced training will be needed for technical staff to enhance their skill	Participant expected that IP certification for technical guy that will execute the changes is needed including all level of training from strategy, planning, execution and operation team	Participant claimed that IT staff need to be trained more especially on the basic Ipv6 addressing, configuration and application of this new protocol	Participant assumed that organisation still can engage with outsider consultant to implement the IPv6 project, but still the technical person need to be trained on certain aspect of IPv6 configuration which will involve cost (this is a problem for organisation)

Theme	**Respondent 1 (MCMC)**	**Respondent 2 (ISP)**	**Respondent 3 (vendor)**	**Respondent 4 (educator)**	**Respondent 5 (bank)**
Motivation	Participant believed that the drivers that motivate the organisation to migrate are IPv6 enable services	Participant agreed that the only driver is IPv4 exhaustion but ‘optimization/ clean up' can be done to gain the IPs	Participant claimed that there is no such thing as IPv4 exhaustion. That is just matter of	Participant agreed that IPV4 exhaustion is the key motivation for the organisation to migrate to IPv6	Participant agreed that motivation to migrate is due to the exhaustive of ipv4 addresses

	offered by ISPs and SPs, users demand, IPv4 exhaustion and IPv6 awareness program		proper IP planning. However, he agreed that the advantage of IPv6 such as simple planning, less processes and at the end better customer experience can be the motivation for organisation to migrate		

Findings from the interview indicate that all three physical factors influencing the organisation readiness toward IPv6 migration that have been identified from the literature are agreed by the respondents consisting of various organisation and expertise. Most of the respondents agree that the organisation need to be well prepared their networking equipment and end user devices before initiate the IPv6 project. This is because, infrastructure such as computer is important to support daily operations while network equipment is essential to establish a connection between the Internet and the host to enable organisation to provide services to clients (Weng, 2012). They suggested the organisation to assess their hardware to identify which devices are compatible with the new protocol to minimize the hardware replacement cost as well as the software updates and upgrades (Dai, 2011). Apart from the costs for hardware and software upgrading, the cost of deploying IPv6 will involve of training, applications upgrading, labour costs and wide variety of other task such as promotion and consultation(Dell, 2012). On the other hand, all respondents agreed that planning is very crucial in the migration project as planning and preparation with full details for each phase will facilitate the successful of IPv6 implementation (Nguyen Phu Minh Nguyen et al., 2012).

Moreover, all the respondents agreed that knowledge, training and motivation might be the factors that influence the readiness towards IPv6 migration which categorised as human factor in the organisation. They accepted that the exhaustion of IPv4 is the key that drive the organisation to migrate to IPv6, even though there was an argue mentioned that the limitation of IPv4 address in Malaysia is still not critical at the moment. Besides, there was an opinion from the respondent claiming that the advantages offered by this new protocol might be the reason to adopt this technology. Additionally, all the respondents agreed stated that the technical staff must be provided with the technical knowledge of hardware and address configuration, troubleshooting issue and routing protocol configuration as well as emphasizing the user with the awareness program to educate them with the basic knowledge of the new address protocol so that they are alert with the importance of IPv6. Failure to promote the importance of IPv6 will creates a lack of demand for IPv6 networks in any organisation (SV Limkar & Jha, 2010).

Respondents also emphasised on the aspect of personnel training which is very important for the organisations that plan to deploy IPv6, because they need to have sufficient skills to configure hardware and software during the migration process. Besides, operating IPv6 in the network will be a different experience for the individuals that directly involved manage the network, so training will be the most important requirement as there are new aspects to handle compared with the IPv4 that they had been familiar with (Weng, 2012). Therefore, some respondents suggested list of training needed by the technical staff including all level of training from strategy, planning, execution and operation such as IPv6 Certification Training and IPv6 Consultative Program.

Findings from this study show that experts agreed and have the same view with factors that might affect the organisation to migrate to IPv6 as identified previously from the literature. They also provide clear explanations

based on their experience directly involved with this matter. Those factors can be considered and given attention by any organisation that plan to migrate to IPv6 as part of their preparation towards the migration process.

4. Conclusion

Due to the rapid growth of IPv4, there are some organisations start to plan to migrate from IPv4 to IPv6 in their network. However, IPv6 adoption progress is still slow because few organisation perceive that the migration towards IPv6 is a complex practice (SV Limkar & Jha, 2010). Therefore, the factors defined in this study can be used to facilitate the organisation heading towards the IPv6 migration. By referring to each factors, it will help organisation to plan and take any action especially in the aspect of available resources and manpower before they decide to implement the IPv6 in their network.

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